et al.); Ore-forming fluids Nigerian mineral belts (Akande and Kinnaird); oxygen and hydrogen isotope study of skarn-type magnetite deposit, Shinyemi mine, Korea (Mariko and Yang); tungsten-bearing gresien veins, Akchatau deposit, Kazakhstan (Zharikov *et al.*); East Kemptville Sn-(Zn-Cu-Ag), Nova Scotia (Kontak); vein gold deposits, Liaoxi uplift, China (Baoqin *et al.*); Hutti gold deposit, India (Pathan and Riyaz Ulla); fluid, chemical and structural evolution of gold-quartz veins, Patchway Mine, Zimbabwe (Herrington *et al.*); Arkhangelsk diamond province (Sinitsyn).

The number of papers on general techniques is rather small although there are useful articles on ICP-AES for fluid inclusion analysis (Rankin *et al.*), temperature-chloride mixing diagrams (Shibue) and computer aids to ore-mineral identification (Laudon and Hagni). In addition there are papers on the behaviour of pyrite in metamorphism (Craig and Vokes), coupled diffusion in the system ZnS–$CuInS_2$ (Bente *et al.*) and fluid transport of ore metals in mantle rocks (Ryabchikov).

There are notable (and, it turns out, deliberate) omissions from this volume. Papers given in special sessions on 'Metalliferous Black Shales and Ore Deposits' and 'Precambrian Ore Deposits and Tectonics' have been or are to be published elsewhere. If you were looking for papers on mineral deposit modelling presented at the concurrent IGUS/Unesco Deposit Modelling Program meeting then you would be disappointed, these papers being published separately by the Geological Association of Canada. Nevertheless, there are some articles primarily addressing modelling; these include: geochemistry of formation of five element (Ag–Ni–Co–As–Bi) veins (Kissin); metallogenic concepts to aid exploration for giant Olympic Dam-type deposits (Gandhi and Bell); cyclicity in the formation of mercury deposits (Maslennikov).

Perhaps the most valuable collective feature of the volume is the large number of papers on deposits rarely described in western journals. In particular there are 20 papers describing deposit in the old Soviet Union and China with a further 20 papers on deposits in other Asian countries (notably India), South America, Africa and Eastern Europe.

The quality of presentation of the volume is excellent and the editorial team are to be commended on the final product. The text is enhanced by 448 figures and 117 tables, a contents list and a list of contributors but no index.

As a collection of studies of the ore geology of specific districts or deposits, this volume meets its purpose admirably. At well over £100, this is not a volume for most peoples' personal collection, however, I would recommend this book as useful reference for libraries requiring such information on a wide variety (both in type and location) of deposits.

D. A. POLYA

Gray, P. J. (Ed.) *Sulphide Deposits - their Origin and Processing*. London (Institution of Mining and Metallurgy), 1990. x + 310 pp., 4 maps. Price £53.00.

Sulphide deposits are hosts to a a major proportion of the world's base and precious metal resources, yet their multi-element content and complex form pose a major challenge to efficient exploitation. There is still a tremendous gap in our understanding of the underlying principles governing the processing of sulphide ores, and this volume aims to record some of the recent progress in this field.

This volume contains 21 papers on the subject of sulphide deposits, but despite the title, the majority focus on the treatment of ores and the extraction of metals, rather than their origin. It is split into three sections: 'Geology, petrology and mineralogy' (5 papers), 'Ore processing and mineralogy' (7 papers), and 'Concentrate processing and tailings disposal' (9 papers). As with all volumes of this nature, the coverage is uneven, although there are also some useful review papers (e.g. 'Compositional and textural variations in major iron and base-metal sulphide minerals'; 'Principles and practice of sulphide mineral flotation'; 'Acid mine drainage from sulphide ore deposits'). The quality of the presentation, although on the whole adequate, is variable, with several disparate styles and layouts.

The value of this volume lies in its descriptions of individual case histories, detailing methods adopted for the recovery of metals from specific sulphide deposits. As such it represents a useful indication of how far metallurgists have progressed in their quest for efficient and reliable techniques for exploiting sulphide deposits.

D. H. M. ALDERTON

Salje, E. K. H. *Phase Transitions in Ferroelastic and co-elastic Crystals: an introduction for mineralogists, materials scientists and physicists*. Cambridge 1993. xiv + 282 pp. Price (paperback) £19.95.

This edition of Professor Salje's previous book with the same title and publisher (1990) has been dedicated specifically to students. A review of the

original edition may be found in this journal, vol. 56, pp. 284–5. The earlier edition contained some nine specialist chapters by a suite of different authors. These have been removed from the new edition. The earlier part of the new issue, comprising the first seven chapters, is likely to be useful to earth science undergraduates with a good background in physics. The remainder of the book is more appropriate to postgraduate students with a special interest in mineral processes and in phase tranformations, since the topics covered are mainly the subject of current research in mineral physics. The author himself provides a brief explanatory guide to the use of the book for students at differing levels and this review provides some additional notes.

All serious students of mineralogy are already conversant with the problems that form the subject matter of this book. They concern the likely behaviour of a macroscopic crystal when undergoing a phase transition with concomitant change in its unit cell constants. A good example is provided by the mineral microcline. This mnineral may readily be recognized in optical thin section from the distinctive cross-hatched pattern of combined albite-pericline twinning which results through the loss of monoclinic symmetry. The pattern of domain structure in nmicrocline is not susceptible to change under stress, at least at strain rates available in the laboratory, but, as noted in chapter 1, there are some mineral phases where the transformation-induced microstructure does change readily under imposed stress. In such a case, suitably imposed stresses yield a macroscopic strain pattern, including strain hysteresis, that is in many ways analogous to the behaviour of a ferromagnetic material in a changing magnetic field. This analogy leads to the definition of ferroelastic and co-elastic materials in chapter 2. It is usual to find that the observed strain at and below a ferrelastic phase transitiion is also a function of temperature and pressure and may be used to define a corresponding state variable.

Chapter 4 deals with the specific strain effects observed in ferroelstic and coelastic mineral systems and demonstrates that the spontaneous strain developed in a true single crystal at a phase transition may be used to define an order parameter (Q) which may conveniently be studied in terms of the Landau free energy expansion which is itself a proper symmetry based thermodynamic description. The relevant aspects of Landau theory are dealt with in Chapter 3.

In many minerals the process of transformation is complex and involves not only a change in symmetry but also a change in atomic structure associated with the ordering of certain atomic species. This is the case in microcline where the triclinic, heavily twinned structure has a new Al/Si distribution which was initially inaccessible under monoclinic symmetry. The extent of this atomic ordering process (order parameter Q_{od}) associated with the phase transition may also be used to develop a Landau free energy expansion.

At this point, in Chapter 5, the author considers the important possibility of coupling and interaction between those aspects of transformation involving spontaneous strain (Q) and atomic ordering (Q_{od}). The practical result depends on the time-scale of equilibration in each case individually and, whereas this may be negligible in the case of the devlopment of a purely spontaneous strain, substitutional ordering effects are notoriously slow and may demand a geological rather than a laboratory time-scale. In any event the description of the ideal interaction terms within the Landau expansion is quite straightforward and the author deals at this point with the most important practical examples namely bilinear coupling and linear-quadratic coupling between strain and order parameters respectively.

The book also provides a detailed account of practical aspects of the macroscopic behaviour of ferroelastic crystals in relation to domain structure and domain boundaries, and a mathematical treatment of their stability and mobility in Chapters 7 and 8. The final four Chapters of the book deal with more complicated aspects of the interaction between different ordering schemes, and between complex ordering patterns and strain. At this point the intending reader may find it necessary to have some background in group and group representation theory. The subject matter of this part of the book is extremely fascinating and highly topical and will certainly lead in the future to a much better quantitative understanding of the transformation behaviour of minerals.

J. D. C. McConnell

Kilburn, C. R. J. and Luongo, G. (Eds.). *Active Lavas*, London (UCL Press), 1993. x + 374 pp. Price £65.00.

The book consists of 14 chapters by 18 authors of three nationalities (Italian, British and American) on the theme of flowing subaerial lava. Chapters are grouped into 4 Parts (Morphology, Monitoring, Modelling, and Mediating), each with a short preface by the editors. No indication is given of the circumstances under which the book came into existence.